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SEVENTY-FIRST

ANNUAL REPORT

OF THE

DIRECTOR

OF

THE ASTRONOMICAL OBSERVATORY

OF

HARVARD COLLEGE

FOR THE YEAR ENDING SEPTEMBER 30, 1916

BY

EDWARD C. PICKERING

CAMBRIDGE, MASS.
PUBLISHED BY THE UNIVERSITY
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THE OBSERVATORY

To the President of the University: —

Sir, — The death of Louisa Winlock deprived the Observatory of a faithful computer who took an active part in its work for nearly thirty years. She devoted several years to aiding in the reduction of each of the meridian circle zones undertaken by this Observatory, and also rendered important aid in the management of the library.

Three large pieces of work are in progress here, the New Draper Catalogue, the determination of photographic magnitudes, and the observation of variable stars. The first of these is advancing rapidly by the help of the gift of Mr. George R. Agassiz. The late Charles S. Hinchman also continued his acceptable contribution to the Maria Mitchell Fellowship.

The plan for protecting from fire the library and collection of photographic plates at moderate expense, as proposed in my last report, has not been carried out for lack of means. This and additional funds for employing temporarily more computers to complete the investigations just mentioned are the greatest needs of the Observatory.

Henry Draper Memorial

The New Draper Catalogue continues under the supervision of Miss Cannon. Eight thousand one hundred and forty-three additional spectra have been classified, thus including moderately bright stars omitted in the original classification, since photographs of some parts of the sky are better than others. The total number of spectra is now 241,193, relating to about 214,000 stars. One-eighth of the stars have therefore been classified independently, on two or more plates. Copy for the printer has been written and partially checked to right ascension $5^h 4^m$. The first four hours will form Volume **91** of the Annals. It is hoped that its publication can begin early in 1917. Thirteen new variable stars have been found, fifty-one stars having composite spectra, and seventeen with bright lines or other peculiarities. Two stars, +43° 53 and the variable, S Cephei, have been shown to be so red that they are photographed with difficulty. The difference between their brightness when photographed with yellow and blue light amounts to five magnitudes, or three times that of ordinary red stars. By placing an objective prism over the 24-inch Reflector, and using plates stained with pinacyanol, the spectra of these and other red stars have been photographed.

The 10-inch Metcalf Anastigmat mentioned in my last report has been placed on the mounting of the 8-inch Draper Telescope. With the latter instrument, 132 photographs have been taken, making 39,294, in all. This instrument has been in constant use for twenty-seven years. The 10-inch Metcalf Telescope is now in regular use. The images are excellent, and the field is very large. Two hundred and twenty-four photographs have been taken, making 245, in all. Many of them give multiple images of the asteroids. Excellent spectra have also been obtained, one of them showing the change in class of spectrum of U Cephei. One thousand one hundred and fifty-seven photographs have been taken with the 1-inch Cooke Telescope, making 17,960, in all, and 1,016 with the 0.5-inch Voigtländer, making 15,141, in all. One hundred and twelve photographs, making 1,727, in all, have been taken with the 24-inch Reflector.

The photographic work at Cambridge has continued under the supervision of Professor King. The total number of plates exposed was 6,664, of which 6,204 related to the stars. One hundred and six plates, making 741, in all, have been taken of the Moon to determine its position, in cooperation with the Princeton and Yale Observatories. Out of focus plates with both blue and yellow light have been taken of a standard electric lamp, of the planets, of the Moon, and of various stars.

Boyden Department

The Arequipa Station has continued under the charge of Mr. Frank E. Hinkley. Two thousand five hundred and ninety-six photographs, making 48,562, in all, have been taken with the 8-inch Bache Telescope. They consist mainly of series plates to supplement those taken with the 16-inch Metcalf Telescope. One hundred and seventy-one photographs, making 11,576, in all, have been taken with the 24-inch Bruce Telescope. The exposure was generally an hour, and part were taken with yellow, and part with blue, light. As gratings have been attached to both of these instruments, they furnish valuable material for determining the absolute magnitudes of the southern stars. Thirty-eight photographs of stellar spectra have been taken with the 13-inch Boyden

Telescope, making 13,083, in all. One thousand two hundred and fifty-five photographs, making 12,540, in all, have been taken with the 1-inch Cooke Anastigmat. The total number of photographs obtained is 4,849, the largest number ever taken. The quality of the plates is also excellent, and the instruments are now in very good condition. The greatest difficulty is the cloudiness. If a really satisfactory location could be found in the southern hemisphere, it might be well to move the Station.

The Mandeville Station in Jamaica has continued under the direction of Professor W. H. Pickering. A special study was made of Mars from which he concludes that the dark areas are changing their positions annually back and forth by a few hundred miles, sometimes carrying the so-called canals with them; that these areas gradually turned green and later brown. Temporary blue areas were detected near the polar cap. The color determinations were made with a tungsten lamp shining through blue glass. The measured breadth of the canals ranged from 30 to 110 miles. The duplication was detected, and attributed to the rapid passage of waves of irregular density in our own atmosphere. The colors of all the planets have been determined and those of the fixed stars begun. The changes in the snow areas on the Moon have been studied and also the elliptical forms of Jupiter's satellites.

Blue Hill Meteorological Observatory

Continuous records of pressure, temperature, humidity, wind direction and velocity, sunshine, evaporation, precipitation, and night cloudiness have been maintained throughout the year, thus completing a series of thirty-one consecutive years. A summary covering a period of thirty years was published in H. A. **73**, Part **3**. This renders accessible the results of the most detailed observations of meteorological phenomena thus far made in New England. It will be remembered that in no other part of the United States have so many records been made extending over various periods. Even from colonial times, many of these records have been noteworthy because of the fidelity of the observers and a conscientious effort to record the facts. Examples of such records are the Holyoke records at Salem and the Rodman records at New Bedford, the latter of which are in the library at Blue Hill.

As a first step in the utilization of the Blue Hill records, Professor McAdie has made a study of the winds of Boston and vicinity. The discussion was published in H. A. **73**, Part **3**. Some of the results have a direct practical bearing on aviation. Thus, the duration of the wind from different directions, the character of the air flow preceding, accompanying, and following certain types of pressure distribution, the change in velocity with elevation, the mechanism of sea breezes, sea turns and east winds at various levels, the diurnal and monsoonal changes, the maximum surface velocities, the prevalence of gusts, the relation of equivents and equipluves are treated with some detail. The paper is illustrated with twenty-two figures.

Photographic Magnitudes

The determination of photographic magnitudes on the international scale has continued under the supervision of Miss Leavitt. The principal use made of the 16-inch Metcalf Telescope has been for this investigation. The greater portion of the photographs have been taken in 138 series of twelve plates each, 80 with blue, and 58 with yellow, light. One thousand nine hundred and forty-eight photographs have been obtained, making 11,255, in all. The magnitudes of sequences in the Harvard Standard Regions are nearly completed, and would be ready for publication as H. A. **71**, No. **4**, but for the unfortunate delay of seven months in the receipt of Case 793 from Arequipa. Magnitudes for 164 of the 252 Selected Areas of Kapteyn have been obtained, including all north of −30°. Catalogues of all the stars in these regions of the fifteenth magnitude, and brighter, have been prepared by Professor Kapteyn and are in process of publication in H. A. **85**. Magnitudes for 108 of the 204 standard regions of the Carte du Ciel have been determined. The total number of estimates of magnitudes is about eighty thousand.

Variable Stars

Numerous observations of variable stars have been made by Mr. Leon Campbell, with the 12-inch Polar Telescope and 15-inch Equatorial. With these instruments, he has made 2,633 estimates of variables, mainly when they were too faint to be observed with smaller instruments. He has made 9,100 settings with the polarizing photometer attached to the 15-inch Equatorial, mainly of Algol stars, of the variable asteroid Eunomia (15), and of twelve eclipses of Jupiter's satellites. Professor H. C. Wilson has made 752, and Professor C. A. Chant 256, photometric settings on SU Draconis.

The British Astronomical Association, under the directorship of Mr. C. L. Brook, has contributed 671 observations and has sent the means for every ten days of 28 variables observed since 1910. The American Association of Variable Star Observers has contributed 11,284 observations under the supervision of Mr. Olcott. Observations have been received from various observers as follows: —

Mr. T. W. Backhouse, 122; Mr. H. L. Baldwin, 55; Mr. H. C. Bancroft, Jr., 2,438; Mr. J. van der Bilt, 61; Rev. T. C. H. Bouton, 601; Mr. C. L. Brook, 76; Mr. A. B. Burbeck, 582; Mr. F. C. Butterworth, 299; Mr. J. J. Crane, 177; Mr. H. O. Eaton, 513; Mr. W. P. Hoge, 127; Mr. S. C. Hunter, 188; Mr. J. B. Lacchini, 630; Mr. F. C. Leonard, 170; Mr. C. B. Lindsley, 125; Mr. W. T. Luyten, 195; Mr. Otto Mach, 302; Mr. C. Y. McAteer, 1,067; Mr. C. S. Mundt, 517; Professor A. A. Nijland, 52; Mr. G. F. Nolte, 293; Mr. W. T. Olcott, 735; Mr. E. de Perrot, 188; Mr. D. B. Pickering, 741; Mr. S. W. Pickering, 78; Mr. C. F. Richter, 687; Mr. H. R. Schulmaier, 50; Mr. F. H. Spinney, 180; Miss H. M. Swartz, 176; Mr. H. Thompson, 115; Mr. H. W. Vrooman, 351; Professor H. C. Wilson, 152; Miss I. E. Woods, 97; Professor A. S. Young, 206. Besides these, 263 observations have been communicated by thirteen observers, each of whom has made less than fifty estimates.

About fifteen thousand unpublished observations have been made and received here during the years 1911 to 1915, and those in the first six hours of right ascension are practically ready for the printer.

Miscellaneous

Phillips Library. — The Library of the Observatory has been increased by 205 volumes and 2,418 pamphlets. As 2,591 pamphlets have been bound in volumes, the present extent of the library is 14,935 volumes and 35,988 pamphlets.

Telegraphic Announcements. — The refusal of the censors to permit cipher messages to be transmitted seriously diminishes the efficiency of the service. Eighteen cablegrams have been sent to Copenhagen, and to astronomers in South America where communication has not been interrupted. It is requested that announcements be sent here, as usual, cablegrams addressed "Observatory, Boston," and telegrams, "Harvard College Observatory, Cambridge, Mass." They will be given as wide a distribution abroad as practicable. Our telegrams are sent at cost to all who wish for them.

Twenty-four bulletins have been issued, making 614, in all. They are printed promptly and not only contain all the telegraphic announcements, but much additional information sent for that purpose. They are sent without charge to all receiving the telegrams, and at a price less than cost to all others desiring them.

Publications. — During the last year, Volumes **73**, Part **3**, Blue Hill Meteorological Observatory, 1915; **76**, No. **10**, Photographic Magnitudes of Polar Stars obtained with the 24-inch Reflector; **76**, No. **11**, The Light Curve of Nova Geminorum, No. 2; **76**, No. **12**, Magnitudes of the Cape Photographic Durchmusterung; **80**, No. **2**, Photographic Plates showing Faint Stars; **80**, No. **3**, Illustrations in the Harvard Annals; **84**, No. **1**, Seven Circumpolar Variables, have been distributed. **71**, No. **4**, Sequences in Harvard Standard Regions; **78**, Part **2**, Variable Stars in the Cluster Messier 5; **80**, No. **4**, Northern Milky Way; **80**, No. **5**, Systematic Photographic Tests, 1911–1915; **80**, No. **6**, Comparison of Stellar Images; **80**, No. **7**, Scale of the Cordoba Durchmusterung, $-52°$ to $-62°$; **80**, No. **8**, The Light Curve of T Andromedae; and **85**, Durchmusterung of Kapteyn's Selected Areas, are partly in type, or at the printer's. The set of Annals from **1** to **80** is, therefore, complete and distributed, with the exception of **71**, No. **4**, **78**, Part **2**, **79**, and **80**, numbers following No. **4**. **84**, No. **1**, is also published. Seven circulars have been issued, whose numbers, titles, and dates are as follows: —

189. Asteroids Bright in 1916. December 29, 1915.
190. Variable Stars of Short Period. January 3, 1916.
191. Nineteen New Variable Stars Near the South Pole. February 19, 1916.
192. Potsdam and Harvard Photometric Magnitudes. June 11, 1916.
193. Cluster Variables with Double Maxima. September 1, 1916.
194. Two New Variable Stars. H. V. 3398 and 3399. September 2, 1916.
195. Probable Error. September 5, 1916.

EDWARD C. PICKERING, *Director.*